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Pomona Reservoir
Osage County, Kansas

National Eutrophication Survey, Corvallis, Oreg

Prepared for

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REPORT

ON

POMONA RESERVOIR

OSAGE COUNTY

KANSAS

EPA REGION VII

WORKING PAPER No. 522

WITH THE COOPERATION OF THE

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

AND THE

KANSAS NATIONAL GUARD

APRIL, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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CONTENTS

	Page
Foreword	ii
List of Kansas Study Reservoirs	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	4
III. Lake Water Quality Summary	5
IV. Nutrient Loadings	10
V. Literature Reviewed	15
VI. Appendices	16

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impacts on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Kansas State Department of Health and Environment for professional involvement, to the Kansas National Guard for conducting the tributary sampling phase of the Survey, and to those Kansas wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staff of the Kansas Division of Environmental Health provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

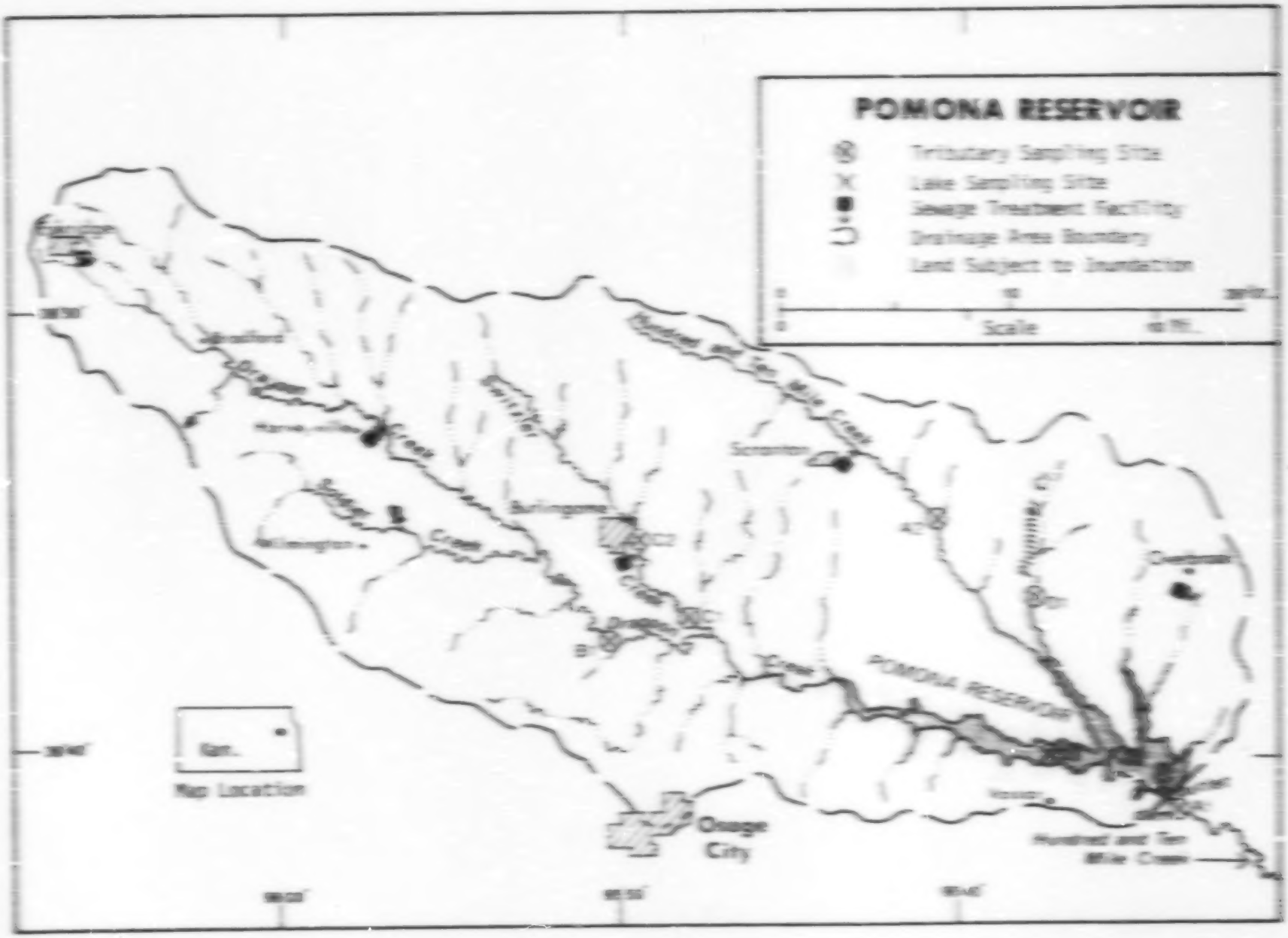
Major General Edward F. Fry, the Adjutant General of Kansas, and Project Officer Colonel Albin L. Lundquist, who directed the volunteer efforts of the Kansas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

STATE OF KANSAS

NAME	COUNTY
Cedar Bluff	Trego
Council Grove	Morris
Elk City	Montgomery
Fall River	Greenwood
John Redmond	Coffey, Lyon
Kanopolis	Ellsworth
Marion	Marion
Melvern	Osage
Milford	Clay, Geary
Norton	Norton
Perry	Jefferson
Pomona	Osage
Toronto	Greenwood, Woodson
Tuttle Creek	Marshall, Pottawatomie, Riley
Wilson	Russell


POMONA RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Drainage Area Boundary
Land Subject to Inundation
Scale
Key Location
Osage City
POMONA RESERVOIR

POMONA RESERVOIR
STORET NO. 2012

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Pomona Reservoir is potentially eutrophic. However, the reservoir becomes quite turbid during periods of runoff, and primary productivity is intermittently light-limited (Kring, 1977).

This water body ranked eleventh in overall trophic quality among the 15 Kansas reservoirs sampled in 1974 when compared using a combination of six water quality parameters*. Four of the reservoirs had less median total phosphorus, nine had less median dissolved orthophosphorus, 13 had less median inorganic nitrogen, five had less mean chlorophyll a, and seven had less mean Secchi disc transparency. Depression of dissolved oxygen with depth occurred at all three sampling stations in June.

Survey limnologists did not observe nuisance concentrations of algae or macrophytes in the reservoir. However, the low Secchi disc transparencies and numbers of phytoplankton (page 7) indicate that reduced light penetration limits primary productivity. In a previous report on this water-body, it was noted that nutrient levels are high at times, but that suspended sediments in the reservoir limit photosynthetic activity (Anonymous, 1975).

* See Appendix A.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Pomona Reservoir was phosphorus limited at the times the samples were collected (04/11/74 and 10/01/74). The reservoir data indicate phosphorus limitation at all sampling stations and times.

C. Nutrient Controllability:

1. Point sources--During the sampling year, point sources contributed 20.5% of the total phosphorus input to Pomona Reservoir. The wastewater treatment plant at Burlingame contributed 5.4%, the plant at Eskridge contributed 4.7%, the facilities at Scranton and Overbrook each contributed 4.3%, and the plant at Harveyville contributed 1.8%.

The present phosphorus loading of 0.98 g/m^2/year is 1.4 times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 14). Nutrient-wise, the reservoir is phosphorus limited, and reduction of phosphorus from point sources should be considered if soil conservation practices are initiated to reduce soil erosion in the drainage and thus reduce turbidity in the reservoir.

2. Non-point sources--Non-point sources accounted for 89.5% of the total phosphorus load during the sampling year. Dragoon and Switzler creeks each contributed 23.8%, Hundred and Ten Mile Creek contributed 6.4%, and Plummer Creek contributed 2.2%. Ungaged minor tributaries and immediate drainage contributed an estimated 21.5%.

The phosphorus export rate of Switzler Creek was three times the mean of the rates of the other gaged tributaries (page 14) and was appreciably higher than the 24 kg/km^2/yr exports of the two gaged tributaries of nearby Melvern Reservoir*. The higher rate may be due to urban drainage from Burlingame since the mean total phosphorus concentration in Switzler Creek at station U-2 upstream from the Burlingame wastewater treatment plant (see map, page v) was a high 0.124 mg/l (Appendix E).

* Working Paper No. 518.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS[1]

A. Morphometry[11]:

1. Surface area: 16.19 kilometers^2.
2. Mean depth: 6.4 meters.
3. Maximum depth: 14.5 meters.
4. Volume: 103.614 x 10^6 m^3.
5. Ten-year median hydraulic retention time: 193 days.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Hundred and Ten Mile Creek	77.4	0.460
Dragoon Creek	295.3	1.690
Switzler Creek	102.3	0.610
Plummer Creek	31.9	0.193
Minor tributaries & immediate drainage -	310.9	2.380
Total	817.8	5.333

2. Outlet -

Hundred and Ten Mile Creek	834.0**	4.660

C. Precipitation***:

1. Year of sampling: 83.1 centimeters.
2. Mean annual: 95.1 centimeters.

[1] Table of metric conversions--Appendix B.
[11] Kring, 1977.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of reservoir.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Pomona Reservoir was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two or more depths at three stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 11.3 meters at station 1, 7.9 meters at station 2, and 6.7 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table.

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/11/74	1. Ankistrodesmus sp.	1,663
	2. Stephanodiscus sp.	489
	3. Melosira sp.	391
	4. Chroomonas sp.	342
	5. Cryptomonas sp.	147
	Other genera	50
	total	3,082
06/25/74	1. Melosira sp.	2,872
	2. Stephanodiscus sp.	801
	3. Euglena sp.	94
	4. Cryptomonas sp.	47
	5. Scenedesmus sp.	47
	total	3,861
10/01/74	1. Melosira sp.	184
	2. Chroomonas sp.	92
	3. Merismopedia sp.	92
	4. Glenodinium sp.	46
	total	414

B. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
04/11/74	1	8.0
	2	9.1
	3	11.3
06/25/74	1	13.8
	2	9.9
	3	7.8
10/01/74	1	2.8
	2	3.8
	3	-

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. April sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.020	1.125	8.8
0.050 P	0.070	1.125	27.5
0.050 P + 1.0 N	0.070	2.125	30.2
1.0 N	0.020	2.125	9.8

b. October sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.010	0.680	0.6
0.050 P	0.060	0.680	14.3
0.050 P + 1.0 N	0.060	1.680	21.8
1.0 N	0.010	1.680	0.6

4. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Pomona Reservoir was high in April and moderate in October. In both assays, increased yields with the addition of phosphorus alone indicate the reservoir was phosphorus limited at those times. Note that the addition of nitrogen alone did not result in yields significantly greater than those of the controls.

The difference in the control yields during the two sampling times indicates differences in availability of nutrients for primary production. Note that orthophosphorus concentrations were two times greater in the April sample.

The reservoir data also indicate phosphorus limitation. The mean inorganic nitrogen/orthophosphorus ratios were 45/1 or greater at all sampling stations and times. However, primary productivity in the reservoir is intermittently light-limited rather than nutrient-limited.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Kansas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the months of April, June, and July when two samples were collected. Sampling was begun in October, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Kansas District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the nutrient loads at station D-1, in $kg/km^2/year$, and multiplying by the ZZ area in km^2.

The operator of the Burlingame wastewater treatment plant provided monthly effluent samples and corresponding flow data. The operators of the wastewater treatment plants at Scranton and Eskridge also provided monthly samples; however, corresponding flow data were not available. Nutrient loads for these facilities and the wastewater treatment plants

* See Working Paper No. 175.

at Harveyville and Overbrook, which were not sampled, were estimated at 1.134 kg P and 3.401 kg N/capita/year, and flows were estimated at 0.3785 m^3/capita/day.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Burlingame*	1,071	tr. filter	233.4	Switzler Creek
Eskridge*	652	stab. pond	946.8	Dragoon Creek
Harveyville**	250	stab. pond	94.6	Dragoon Creek
Overbrook**	600	stab. pond	227.1	Unnamed creek
Scranton*	601	stab. pond	227.5	Hundred and Ten Mile Creek

2. Known industrial - None

* Treatment plant questionnaires.
** Anonymous, 1971.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Hundred and Ten Mile Creek	1,010	6.4
Dragoon Creek	3,780	23.8
Switzler Creek	3,780	23.8
Plummer Creek	355	2.2
b. Minor tributaries & immediate drainage (non-point load) -	3,420	21.5
c. Known municipal STP's -		
Buellingame	860	5.4
Eskridge	740	4.7
Harveyville	285	1.8
Overbrook	680	4.3
Scranton	680	4.3
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	285	1.8
Total	15,875	100.0

2. Outputs -

Reservoir outlet - Hundred and Ten Mile Creek	13,385

3. Net annual P accumulation - 2,490 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Hundred and Ten Mile Creek	44,634	12.1
Dragoon Creek	120,805	32.6
Swiftwater Creek	57,920	15.6
Plummer Creek	11,150	3.0
b. Minor tributaries & immediate drainage (non-point load) -	108,815	29.4
c. Known municipal STP's -		
Burlingame	2,080	0.6
Eskridge	2,215	0.6
Harveyville	850	0.2
Overbrook	2,040	0.6
Scranton	2,045	0.6
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	17,480	4.7
Total	370,035	100.0

2. Outputs -

Reservoir outlet - Hundred and Ten Mile Creek	316,370

3. Net annual N accumulation - 53,665 kg.

* See Working Paper No. 175.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Hundred and Ten Mile Creek	13	577
Dragoon Creek	13	409
Switzler Creek	37	666
Plummer Creek	11	350

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not is applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m²/yr	0.98	0.15	22.9	3.3

Vollenweider phosphorus loadings (g/m²/yr) based on mean depth and 10-year median hydraulic retention time of Pomona Reservoir:

"Dangerous" (eutrophic loading)	0.68
"Permissible" (oligotrophic loading)	0.34

V. LITERATURE REVIEWED

Anonymous, 1971. Inventory of municipal waste facilities. EPA Publ. OMP-1, vol. 7, Wash., DC.

Anonymous, 1975. Draft environmental statement: Operation and maintenance - Pomona Lake, Kansas. U.S. Army Engr. Distr., Kansas City, MO.

Kring, R. Lynn, 1977. Personal communication (revised reservoir morphometry; primary productivity). KS Dept. of Health & Environment, Topeka.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN HARMONIES

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	SUB-MEDIAN SEC	MEDIAN CHLOPH	25-MEDIAN DO	MEDIAN SECCHI DEPTH P
2801	CEDAR BLUFF RESERVOIR	0.017	0.655	431.857	4.257	10.850	0.834
2802	COUNCIL GROVE	0.369	0.830	485.895	6.786	10.488	0.629
2803	ELK CITY	0.838	0.598	490.401	3.232	14.082	0.970
2804	FALL RIVER RESERVOIR	0.853	0.478	429.667	7.683	9.298	0.834
2805	JOHN REDMOND RESERVOIR	0.119	1.258	492.667	9.467	8.298	0.296
2806	KANOPOLIS RESERVOIR	0.856	0.648	487.888	16.833	10.286	0.811
2807	MARION RESERVOIR	0.852	0.436	485.667	12.488	9.866	0.850
2808	MELVERN RESERVOIR	0.834	0.265	459.111	38.488	14.488	0.857
2809	MILFORD RESERVOIR	0.879	0.718	486.333	16.883	12.866	0.826
2810	NORTON RESERVOIR	0.122	0.838	476.758	21.368	8.888	0.836
2811	PERRY RESERVOIR	0.855	0.476	478.571	5.634	13.488	0.877
2812	POMONA RESERVOIR	0.848	1.248	481.333	8.382	13.888	0.821
2813	TORONTO RESERVOIR	0.867	0.425	488.588	6.583	13.888	0.811
2814	TUTTLE CREEK RESERVOIR	0.192	0.478	478.667	21.278	13.688	0.867
2815	WILSON RESERVOIR	0.823	0.286	465.222	8.867	13.488	0.884

17

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
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7	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
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14	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]

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APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107 x 10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

APPENDIX D

PHYSICAL and CHEMICAL DATA

APPENDIX C

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

[illegible]

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DATE	TIME	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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